# Technical Question T10: Hot & Cold Break

I’ll be shooting for around 400 words to answer this similar to another judge whose answers for 2 pages worked out well at 2 pages/400 words.

I reference Tom’s materials as well as internet searches because sometimes his is too technical for me to remember.

<https://beerandbrewing.com/cold-break/>

Hot break or Kettle break is a term used to describe the large amount of brownish and greenish scum on the top of the boil kettle that forms just as the wort is coming to a rapid boil. If you’ve ever experienced a boil over, that is the hot break.

Cold Break is the term used to describe what we see as large clumps of materials forming together post-boil when we are rapidly cooling our wort down. It starts once the beer goes under 140F in the cooling process and is easily observed as it appears like the flakes of curd you see in miso soup.

In the hot break, proteins in the wort coagulate together, and with other materials such as carbohydrates and polyphenols, and fall out of solution. This includes undesirables such as tannins. This “clumping together” is promoted by bring the wort to a boil as quickly as possible and keeping it at a rolling boil throughout a long boil of at least 60 minutes.

Cold break is similarly a coagulation of mostly proteins but also tannins that is caused by rapidly cooling the beer down as quickly as possible. Short and medium length proteins and carbohydrates that were soluble at boiling temperatures will come out of solution starting at 140F all the way down to 70F. A good wort chiller is key as the rapid change is essential here.

Healthy hot break and cold break are essential to the clarity and shelf life of your beer. The sludge removed are proteins and tannins which are primaryculprits in chill haze. The lipids, carbohydrates and proteins that are precipitated by the hot and cold break are also potential culprits in DMS, fusel alcohols and off flavors(via tannins). These effect the shelf life. Note that it’s not only important to create a healthy hot break and cold break. You must also take care to remove the break material from the wort before fermentation. Either by whirlpooling and/or transferring the wort to a vessel and then transferring it again one it settles. (before fermentation) The wort should not remain in contact with the bulk this material for an extended period of time. I usually rack to a clean vessel, wait 24 hours for the beer to cool to pitching temperature, rack to a fermentation vessel(leaving break) and then pitching/aerate. Bottom line is a solid hot/cold break strategy will help you produce good looking, clear beer that will maintain desired flavor longer.

# Technical Question T10. “Hot & Cold Break”

# What is meant by the terms hot break and cold break? What is happening and why are they important in brewing and the quality of the finished beer? Address the following topics:

|  |  |
| --- | --- |
| **30%** | **Describe each term.** |
| **30%** | **Identify what is happening.** |
| **40%** | **Describe why they are important in brewing and the quality of the finished beer.** |

**1) Hot Break**

***Describe:*** Hot break (AKA Kettle Break) is an albuminous precipitate formed primarily during the first 5-20 minutes of the wort boil (Palmer, p. 81), consisting of denatured high molecular-weight proteins which have polymerized with carbohydrates and polyphenols (especially tannins, but also anthrocyanogens and flavanols) but also containing contains lipids and other compounds. The exact composition is about 50-60% protein, 20-30% polyphenols, 15-20% hop resins, and 2-3% "ash" (i.e., other materials, such as insoluble salts).

It forms at a rate of about 20-40 ppm. When it first forms it appears as a brownish or greenish scum on the top of the boil kettle and is a major factor in boilovers. In suspension, the trub particles initially have the appearance of small whitish flakes which grow larger as flocculation continues. By the end of the boil, the break can have the appearance of egg whites in egg-drop soup. When precipitated, it mixes with hop debris and has a greenish-brown slimy appearance.

***What’s Happening:*** Hot break begins forming at the start of the wort boil (at 212 °F). 60% of the hot break is formed within the first 5% minutes of boiling, but longer boils times will increase this figure, up to 95% protein removal after a 2 hour boil. (Barchet) The proteins coagulate, clump together and sink to the bottom of the brew kettle. They can then be separated from the rest of the wort when it is transferred to the fermentor.

The chemical process which causes the hot break is electrostatic attraction - the same principle which allows various types of finings to work. At wort boiling temperatures, normally soluble proteins are denatured by the heat, increasing their positive charges, making them more electrostatically attractive. They then interact with negatively charged polyphenols (mostly tannins), carbohydrates, lipids and other materials to form larger molecules which precipitate more quickly and which can be more easily filtered.

Hot break should be removed from the wort before it is chilled. Methods of removing the hot break include settling, filtration, hopbacks and whirlpooling. (Barchet) It can also be skimmed off the top when it foams up as the kettle comes to a boil.

**Factors Affecting Hot Break Formation**

***1) Type and amount of malt and adjuncts.*** Grains higher in proteins and beta-glucans produce more hot break. This includes malts made from poor-quality (i.e. high nitrogen) or poorly modified malt (e.g., traditional American 6-row, although modern malts are all relatively low in nitrogen). This also includes other types of grains or malts with high proteins or beta-glucan levels, such as wheat, rye and oats.

***2) Mashing schedule:*** An excessively short or long protein and/or beta-glucan rest will reduce hot break formation. An insufficiently long rest leaves most of the proteins and beta-glucans in the grain, while an excessively long rest will break down long-chain proteins into polypeptides and peptides, which are more soluble in wort.

***3) Boil Time:*** *A full, rolling boil of 60+ minutes* is necessary for sufficient *proteins to precipitate*, but hot break is *maximized by a 2 hour, extremely agitated boil*. With well-modified modern malts, however, there is less need for long or aggressive boils (as little as a 2% volume reduction using modern malts). At wort boiling temperatures, normally soluble proteins are denatured by the heat, increasing their positive charges, making them more electrostatically attractive.

***4) Boil Vigor:*** Rolling boils are necessary to agitate the wort, so that the molecules which form the hot break can better interact. *Hot break is improved by a quick rise to boiling temperature.*

***5) Wort pH:*** Low pH worts (below 5.3 at room temperature) render proteins more soluable, making them harder to precipitate. Worts below pH .50 make hot break impossible.

***6) Presence of polyphenols:*** The presence of tannins, and to a lesser extent, anthrocyanogens and flavanols, increases hot break formation. In properly produced wort, most of these products will come from boiling hop additions, but in wort where particles of grain husks have been carried into the wort, or where tannins have been extracted from grain husks by improper mashing techniques, there may be significant levels of malt-derived tannins as well. If not precipitated, these will be a major contributor to chill haze.

***7) Kettle finings:*** Kettle finings, such as Irish Moss or Whirlfloc™, aid in the precipitation of the hot break. Bentonite added to the boil achieves the same effect. The positively charged fining particles attract negatively-charged tannins and carbohydrates helping them to flocculate and increasing the rate at which they precipitate.They are typically added 15-20 minutes before knock-out so they have time to work.

***Why is it Important?:*** A good hot break is necessary for storage stability and to reduce haze formation. If not precipitated, tannins and proteins can complex at cool temperatures to form an unsightly haze, while suspended medium- to long-chain polypeptide and starch molecules can form hazes at any temperature.

Just as important, if not precipitated and removed from the wort before it is pitched, fatty acids (lipids) present in the beer can oxidize during conditioning or storage to produce a variety of unpleasant oxidized notes, primarily papery, cardboard-like aromas and flavors (trans-2-nonenol), but also goaty, sweaty or rancid notes (caproic, caprylic and capric acids). Polyphenols carried into the wort can oxidize to produce harsh, astringent "solventy stale" (furfural ethyl ether) notes and haze. Oxidation of proteins can result in permanent haze.

If *hot break* isn’t removed from the wort before it goes into the fermenter, it will be *carried over into the finished beer,* where proteins in the hot break *can cause off-flavors, chill/protein haze and flavor instability.* High levels of hot break products in the fermenter can also cause the yeasts to produce *excessive levels of fusel alcohols & sulfur compounds*.

**2) Cold Break**

***Describe:*** Cold break is the *coagulation and precipitation of proteins, carbohydrates and other materials during wort cooling.* It consists of short- and medium-chain proteins polymerized with carbohydrates and polyphenols not precipitated during the hot break, as well as up to 50% fatty acids (mostly oleic and linoleic acids). It has the appearance of egg whites in egg-drop soup.

**What’s Happening:** Cold break begins at about 140 °F and is maximized if the wort is rapidly cooled to a temperature of less than 70 °F.

Short- and medium-chain protein and carbohydrate molecules, which were previously soluable in the wort at boiling temperatures, become insoluble as the wort cools and its saturation point decreases. As the molecules fall out of solution, they are electrostatically attracted to each other, flocculate and precipitate just like the hot break.

Material congealed by the rapidly cooling temperatures sinks to the bottom of the kettle, so that it remains behind when the wort is transferred to the fermentor. Commercial breweries sometimes *increase removal of cold break by whirlpooling* the cooled wort or by running it through a *hopback or filter*. *Some cold break should remain* in the wort to provide yeast nutrition, however.

**Factors Affecting Cold Break Formation**

1) Type and amount of wort and adjuncts: As for Hot Break.

2) Wort pH: As for Hot Break.

3) Presence of polyphenols: As for Hot Break.

4) Use of Finings: As for Hot Break.

5) Rapid Cooling: Quick cooling results in better cold-break formation (Miller, p. 134, Noonan, p. 249). Ideally, the wort will be chilled to as low a temperature as possible (down to 32 °F)

***Why is it Important?:*** If *cold break* isn’t removed from the wort before it goes into the fermenter, it will be *carried over into the finished beer*, where proteins and polyphenols (tannins) in the cold break *can cause off-flavors, chill/protein haze and flavor instability.* High levels of cold break products in the fermenter can also cause the yeasts to produce *excessive levels of fusel alcohols & sulfur compounds (DMS).* Reduced cold break also increases the clarity of the finished beer.

A good cold break is necessary to remove lipids from wort, as well as additional proteins, tannins and carbohydrates not precipitated by the hot break. Removal of lipids results in better head formation and stability, and prevents staling (Fix, p. 29). Some of the fatty acids present in cold break are necessary for yeast development and health (they are used for form yeast cell walls), so some cold break should be carried into the fermenter. Trub particles can also act as nucleation sites for CO2 bubbles to form, helping to remove CO2 from the fermenting wort, further aiding yeast metabolism.

Some commercial breweries pitch their yeast into partially clarified wort, let the yeast work for 12-24 hours and then transfer the fermenting wort into the main fermentation tank, leaving most of the break behind.

The Cold Break also helps to precipitate complexed proteins and polyphenols responsible for chill haze, as described for hot break.

If hot and/or cold break are carried into the fermenter, the higher levels of amino acids and fatty acids will result in the yeast producing higher levels of higher alchols and lower levels of esters.

# Question T10 “Hot and Cold Break” Sample Answer

|  |  |
| --- | --- |
| Meaning | What’s happening? Why important? |
| Hot Break | \* Flocculation of proteins and other materials during wort boil. \* Begins forming at start of boil - 212 °F. \* Removes proteins that cause chill haze & flavor instability. \* pH 5.2 ideal. \* Achieved by full, rolling boil of 60+ min. \* 2 hr. boil = max. hot break. \* Aided by quick temperature rise. \* Controversy regarding removal during boil or not. |
| Cold Break | \* Flocculation of proteins & other materials during wort cooling. \* Begins at ~140 F. \* Removes proteins & polyphenols (tannin) complexes responsible for chill haze & flavor instability. \* Removes more carbohydrates than hot break. \* Wort must be rapidly cooled below 70 °F max. cold break. \* Reduces fusels & sulfur flavors. \* Aids beer clarity. \* Reduces DMS. \* Some cold break must be let into fermenter to provide yeast nutrient. |